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Resonant Scattering Studies on Half-doped La(1-x)Sr(1+x)MnO4

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Beamline(s): X22C

The existence of charge valence ordering in the manganites is still debated. In 1998 Murakami et al. succeeded in using resonant x-ray scattering (RXS) as a probe for charge and orbital ordering [1]. The existence of forbidden reflections at the Mn-K edge and a sinus-squared azimuthal dependence in the π-polarization channel has been taken as evidence for orbital ordering. In the underlying model the latter is caused by an anisotropic scattering tensor due to an anisotropic charge distribution associated with orbital ordering. Following experiments reveal also an azimuthal dependence for charge order peaks [2].
The transition at the K edge probes an anisotropic splitting in the 4p level of Mn but the model predicts a splitting in the 3d levels due to a combination of charge- and orbital-order. Until today it is discussed wether the 4p-splitting has to be attributed to the splitting of the 3d levels or to a lattice modulation. A neutron structure refinement done on $Pr_{0.6}Ca_{0.4}MnO_3$ gives no evidence for charge ordering [3]. A model of localized Zener polarons with isovalent Mn-atoms is suggested instead. XANES data taken on different perovskite manganites [4] also let the question arise if the picture of charge order on the Mn-sites can be hold. Linear combinations of spectra from pure (4+)- and (3+)-valent substances can not reproduce the ones from samples with intermediate composition. Going out from these results it is also doubted that RXS data taken on materials with differences in the azimuthal dependence can be described with the same model. The modified model that is suggested predicts a systematical shift of the resonance peak with the azimuthal angle [5].
In order to clarify the discussion we decided to use a sample of $La_{0.5}Sr_{1.5}MnO_4$, a model system for CE-type ordering. A single crystal made of this material has been cut, polished and mounted inside a closed cycle cryostate. We used an RXS setup to measure the dependence of the scattered intensity on energy (around the Mn-K edge, 6.554 keV), azimuthal angle and polarization.

Our results are shown in Fig. 1. The left side presents the azimuthal dependence of the integrated intensity of the (1.5 1.5 0) “charge order” reflection at 80K. A $\sin^2$- and $\sin^4$-curve is fitted to the data. Additionally the position of the resonance peak seems to shift systematically. Therefore further studies are necessary to answer the question of charge order in the manganites.

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References:

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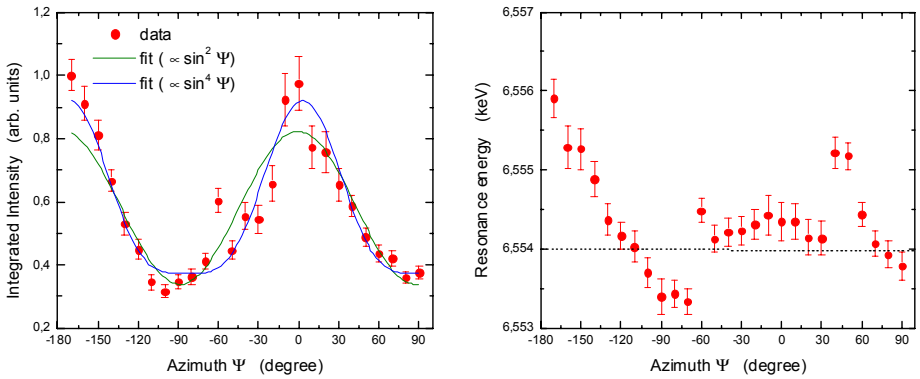

Figure1: *Left:* Azimuthal dependence of the integrated intensity of the (1.5 1.5 0) reflection attributed to charge order in σσ-geometry at 80K. The data has been fitted to a sinus squared and a sinus quartered. *Right:* Position of the resonance peak in the energy scans on the (1.5 1.5 0) reflection in σσ-geometry against the azimuthal angle at 80K. The deviations from the energy of the Mn-K edge (dotted line) seems to vary systematically.